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(54) Title: PROCESS FOR PRODUCING A SOFT, FLEXIBLE, HOT MOLDED POLYURETHANE FOAM (57) Abstract A process for the preparation of a soft, flexible, hot molded polyurethane foam is prepared by reacting a polyol formulation comprising a polyether polyol, a non-trimerization polyurethane catalyst and water with an organic isocyanate under hot molding conditions. The polyol formulation further comprises (a) at least one poly(oxyalkylene) polyether polyol having functionality of at least two, an ethylene oxide content of at least 80 percent and a molecular weight greater than 1,000; and (b) at least one monofunctional additive. The addition of a least one monofunctional additive and at least one poly(oxyalkylene) polyether polyol of functionality of at least two, an ethylene oxide content of a least 80 percent and a molecular weight greater than 1,000 to a conventional polyether polyol formulation has positive effect on foam processing, cell opening, and foam softness and does not negatively affect foam aging properties, especially its compression sets.		

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PROCESS FOR PRODUCING A SOFT, FLEXIBLE, HOT MOLDED POLYURETHANE FOAM

The present invention relates to a process for producing a soft, flexible, hot molded polyurethane foam and to a polyurethane foam thus produced.

Soft, flexible, water-blown, hot-molded polyurethane foams are the product of a reaction of an isocyanate with a polyol formulation typically containing polyether polyols, water, a foam stabilizer and catalysts. Other additives such as fire retardants, auxiliary blowing agents, fillers, dyes, pigments and antioxidants may also be used. The reaction of water with isocyanate liberates carbon dioxide gas which causes expansion of the foam.

Hot-molded polyurethane foams are an important segment of molded foams produced in Europe and still represent over one third of molded polyurethane foams produced for automotive seating applications in Europe and Japan. The reasons for the continued success of hot molding technology, which was the first polyurethane molding technology to be used industrially for car seats more than 25 years ago, are the superior flow properties and the open-cell structure of the foam which properties allow for the manufacture of foam parts with low weights without crushing at demold. Another advantage of hot molding is that it does not require addition of an auxiliary blowing agent to get the proper flow, even in intricate molds.

However, CFC-11 blowing agent was incorporated, as an auxiliary blowing agent, into some hot molding formulations in the past in order to obtain low density, soft foams, using relatively low water levels. This was essentially the case for polyurethane foams used in backrests.

Several options are now available to obtain the same softening effect without the use of the CFC-11 blowing agent which can be harmful to the environment. These and other methods dealing with the subject of softening conventional flexible polyurethane foams are described in the publications mentioned hereinbelow:

A technical report entitled "CFC-Free Hot Curing Moulded Flexible Foam for Automotive Seating," by H.G. Schneider et al published at the "Polyurethane World Congress 1991" in Nice, France by SPI and ISOPA.

A technical report entitled "A Versatile and Comprehensive Approach to CFC-Free Polyurethane Hot-Molding" by S. Pique published at U-Tech 92.

These two technical reports confirm that the elimination of CFC blowing agents from hot-molding polyurethane formulations, and the corresponding increase in water levels, are resulting in foam processing difficulties as well as poorer foam physical properties, especially in terms of foam aging.

European Patent 0 386 974 (PMC Inc.) claims the use of a variety of monohydroxy materials in the preparation of flexible foams, but as indicated in most of the examples values of air flow obtained are low and in most cases unacceptable for an industrial application.

European Patent 0 361 334 (The Dow Chemical Company) teaches a combination of polyether monoalcohols and trimerization catalysts. However, it is known that trimerization catalysts negatively affect the tin latitude, which is a critical parameter for a proper industrial use.

5 U.S. Patent 4,950,694 (Union Carbide Corp.) deals with very low isocyanate indexes, between 60 and 95, through the use of crosslinking/extending agents. Polyethylene oxide monols and/or polyols having an ethylene oxide content of greater than 50 percent and an equivalent weight between 200 and 5,000 are also employed. The application is slabstock foams and the problem of foam curing in a molding situation at these low indexes is not
10 addressed in this reference.

U.S. Patent 5,132,333 (Goldshmidt A.G.) describes a method for producing flexible urethane foams by using an alkali metal salt or an alkaline earth metal salt of a hydroxycarboxylic acid. This approach, designed for a free rise foam, is difficult to put into practice in hot molding because of the variety of foam hardnesses to produce on an industrial
15 line which cannot be adjusted with this type of additives used at very low concentration.

U.S. Patent 4,686,240 (Union Carbide Corp.) relates to a process involving foam modifiers which improve foam green strength at demold. Again, these foam modifiers being alkali metal or alkaline earth salts, are used at low levels and cannot be employed to adjust foam hardness on a hot molding line.

20 European Patent 0 459 622 (Arco Chemical Technology Inc.) describes a novel polyurethane resin foam combination which contains low molecular weight polyethylene glycol along with higher molecular weight polyalkylene oxide triol. The lower molecular weight polyethylene glycol is from 200 to 600. This type of polyethylene glycol does not bring the foam softening level required in hot molding.

25 European Patent 0 367 283 (Union Carbide Chemicals and Plastics Company Inc.) claims the use of ethylene oxide adducts of di- and tri-functional starters as additives improving wet-set properties of high resilience foams. This property usually does not create any difficulty in hot molding, even without additives.

European Patent 0 554 721 (Bayer AG) describes a combination of a conventional
30 polyol (glycerine-started) having an ethylene oxide content of less than 20 percent with a polyether having a functionality of two or higher, a minimum ethylene oxide content of 50 percent and a molecular weight of 400 to 10,000. While this approach is giving better processing at relatively high isocyanate indexes, its softening effect is limited to a level which is not low enough to fully substitute the auxiliary blowing agents traditionally used by the
35 industry.

U.S. Patent 3,857,800 (Dunlop) uses a mixture of a conventional polyol with a subsidiary polyol having a molecular weight between 500 and 3,500 and with at least 40 percent by weight oxyethylene groups to get open celled foams. While this reference is

directed mostly to highly resilient foams, it is clear to those skilled in the art that the auxiliary polyol used in the reference does interfere with the separation of polyurea hard segments produced by the water-isocyanate reaction and will soften any type of foam produced with it; although no comparative hardness measurements are provided.

- 5 It is clear that there exist a need for a method in which a soft, flexible, hot-molded CFC-free polyurethane foam having improved softness and processing characteristics can be made.

Accordingly, the present invention concerns a process for producing a soft, flexible, hot molded polyurethane foam which process comprises reacting a polyol formulation
10 comprising a polyether polyol, a non-trimerization polyurethane catalyst and water with an organic isocyanate under hot-molding conditions, characterized in that said polyol formulation further comprises (a) at least one poly(oxyalkylene) polyether polyol having a functionality of at least two, an ethylene oxide content of at least 80 percent and a molecular weight greater than 1,000, preferably between 2,000 and 12,000; and (b) at least one monofunctional
15 additive. Normally, the first mentioned polyether polyol will contain no more than 10% ethylene oxide.

In another embodiment, the present invention concerns a soft, flexible, hot-molded polyurethane foam prepared by the aforementioned process.

It has been surprisingly found that the addition of at least one monofunctional
20 additive and at least one poly(oxyalkylene) polyether polyol having a functionality of at least two, an ethylene oxide content of at least 80 percent, and a molecular weight greater than 1,000 to a conventional polyether polyol formulation, has a positive effect on foam processing, cell opening, and foam softness. In addition, it has been found unexpectedly that the addition of these two components to the polyol formulation does not affect negatively foam aging
25 properties, especially its compression sets. Furthermore, the addition of these two components to the polyol composition widens the mold temperature latitude, which is very important for industrial applications. Moreover, by resulting in a polyurethane foam having a smooth skin, the present invention provides foam parts showing reduced friction between the foam cushion and the metal frame supporting the seat. This friction is known to cause a disturbing noise for
30 car passengers during a ride, and is referred to in the industry as foam squeaking.

Any of the polyether polyols normally used for the preparation of hot-molded flexible polyurethane foams may be used in the process of the present invention. These polyether polyols are well known in the art, are readily available and include the addition products of alkylene oxides with polyhydric compounds having from 2 to 8 active hydrogen-
35 containing groups per molecule. Examples of polyhydric compounds that are suitable as starting materials for making the alkylene oxide adducts comprise, for example, water, glycerol, trimethylolpropane, pentaerythritol, hexanetriol, hexitol, heptitol, sorbitol, sucrose, amine compounds, such as ethylene diamine and aminoethylpiperazine, and mixtures of two or more of the aforementioned compounds. The alkylene oxide adducts of the polyhydric

initiator can be prepared using techniques well known to those skilled in the art of preparing polyether polyols.

Other suitable polyether polyols are those known as polymer polyols or grafted polyols, such as those modified by copolymerization with styrene or mixtures of styrene with acrylonitrile (known as S/AN copolymer polyols), or combinations of amines or olamines with isocyanates (known as PHD or PIPA copolymer polyols). These modified polyether polyols are commercially available.

Preferred polyether polyols for use in this invention are the addition products of alkylene oxides with polyhydric compounds having 2 to 4 active hydrogen-containing groups per molecule and wherein the addition product has a hydroxyl number of from 20 to 120, preferably from 20 to 80.

The polyol formulation can comprise a mixture of one or more polyether polyols and/or one or more polymer polyols whereby the preferred composition contains at least one polyether polyol which is trifunctional. Illustrative of such a polyether polyol, for example, is glycerine which is alkoxyated with one or a combination of oxides including ethylene oxide, in a block or random form so as to provide a polyether polyol containing from 20 to 90, preferably from 35 to 90 percent primary hydroxyl and having a hydroxyl number from 20 to 100.

Any known poly(oxyalkylene) polyether polyol having a functionality of at least two, an ethylene oxide content of at least 80 percent and a molecular weight greater than 1,000, preferably between 2,000 and 12,000 can be used in the process of the present invention. Examples of these polyether polyols include polyethylene glycols, poly(oxyethylene) triols and poly(oxyethylene/oxypropylene) polyether polyols having an ethylene oxide content of at least 80 percent. The poly(oxyalkylene) polyether polyol is used in an amount of from 0.1 to 20 parts per hundred parts (php), preferably from 1 to 10 php, of the polyol formulation.

Monofunctional additives useful in the process of the present invention are well known in the art and include, for example, monols, amines and monocarboxylic acids. The monofunctional additive is preferably used in an amount of from 0.1 to 20 php, more preferably from 1 to 18 php, of the polyol formulation.

Monols useful in the present invention include, for example, monohydroxy polyalkylene adducts. The monohydroxy polyoxyalkylene adducts useful in the present invention can be prepared by the reaction of a monohydroxy initiator with propylene oxide and an additional alkylene oxide, preferably ethylene oxide or butylene oxides in the presence of a suitable catalyst, as described in European Patent 0 361 334.

Amines useful in the present invention include, for example, primary and secondary amines, such as hexyl amine, octyl amine, nonyl amine and diethyl amine.

Monocarboxylic acids useful in the present invention include, for example, oleic acid and 2-ethyl hexanoic acid.

The organic isocyanates which are useful in the present invention include those containing at least two isocyanate groups per molecule. Preferably, the isocyanate employed contains an average of from 2.0 to 3.0 isocyanate groups per molecule. Suitable isocyanates include aromatic isocyanates, aliphatic, cycloaliphatic and heterocyclic isocyanates used alone or in admixture. The preferred isocyanates used in the practice of this invention are aromatic isocyanates and include the toluene diisocyanates, especially 2,4- and 2,6-toluene diisocyanate (TDI) as well as any desired mixture of these isomers; 2,4'- and 4,4'-diphenylmethane diisocyanate (MDI) as well as any desired mixture of these isomers; oligomers of MDI (polymeric MDI), polymethylene polyphenyl polyisocyanates (commonly referred to as "crude MDI"); mixtures of TDI and polymeric MDI and mixtures of these polyisocyanates. Prepolymers of the above isocyanate (for example, with polyether polyols, glycols or mixtures of these) can also be used in the present invention. The preferred isocyanate is 80/20 TDI (a mixture of 80 percent 2,4-toluene diisocyanate and 20 percent 2,6-toluene diisocyanate).

The polyol formulation is advantageously reacted with an organic isocyanate such that the ratio of isocyanate groups of the organic isocyanate to the active hydrogen-containing groups of the polyol formulation, including water, is from 0.8:1 to 1.2:1, preferably from 0.85:1 to 1.15:1.

Water is used as a blowing agent. The reaction of water with isocyanate liberates carbon dioxide which causes the foam to expand, thus acting as a blowing agent. Water can be present in the polyol formulation in an amount from 1 to 8, preferably from 2 to 6, most preferably 3 to 5 parts by weight per 100 parts by weight of total polyol present. Conventional auxiliary blowing agents not reactive with isocyanate can also be employed in the present invention, but they are not required.

Any of the non-trimerization polyurethane catalysts normally used in the preparation of hot-molded flexible polyurethane foams may be used in the process of the present invention including various tertiary amines and organometallic compounds. The polyurethane catalyst is used in amounts well known to those persons skilled in the art.

Various tertiary amines are conventionally used as non-trimerization catalysts in the production of polyurethane foams. Illustrative tertiary amines which can be used in the present invention include triethylene diamine, pentamethyldiethylenetriamine, N-ethylmorpholine, N-2-dimethyl-ethylenemorpholine, bis(dimethylaminoethyl)ether and other compounds well known to those skilled in the art. Such tertiary amines are used in amounts of from 0.05 to 2.0 parts by weight of the total polyol present. Preferably they are used in amounts of from 0.1 to 1.5 parts.

Organometallic compounds are also conventionally used as catalysts in the production of polyurethane foams. Illustrative organometallic compounds which can be used as catalysts in the present invention include carboxylic acids salts of tin, bismuth, or zinc such as stannous octoate, stannous acetate, stannous laurate and dialkyl tin salts such as dibutyl tin

dilaurate and dibutyl tin maleate. The organic metal catalyst is normally used in amounts of from 0.03 to 2.0, preferably from 0.05 to 1.0 part by weight per 100 parts by weight of total polyol present. The preferred organometallic catalyst for use in the present invention is stannous octoate. These and other organometallic compounds are described in U.S. Patent
5 2,846,408.

Mixtures of catalysts may also be employed in the process of the present invention. Such mixtures of catalysts include mixtures of two or more tertiary amines, mixtures of two or more organometallic compounds and mixtures of at least one tertiary amine with at least one organometallic compound.

10 Any of the foam stabilizers or surfactants for cell stability or other cell size control agents normally used in the preparation of hot molded flexible polyurethane foams can be used in the process of the present invention. In general, representative foam stabilizers are alkoxysilanes, polysilylphosphonates, polydimethyl-siloxanes, the condensates of ethylene oxide with a hydrophobic base formed by condensing propylene oxide with propylene glycol,
15 the alkylene oxide adducts of ethylene diamine, and the polyoxyalkylene esters of long-chain fatty acids and sorbitan, and (siloxaneoxyalkylene) block copolymers. Examples of suitable surfactants or foam stabilizers are the Tegostab BF2370, Tegostab B8002 and Tegostab BF4900 products sold by Th. Goldschmidt. Similar products are sold by OSI Specialties S.A., Air Products and Chemicals Inc., and Dow Corning. The foam stabilizers, surfactants for cell stability or other
20 cell control agents are used in amounts well known to those persons skilled in the art. Mixtures of one or more stabilizers and/or one or more surfactants may also be used.

Known crosslinkers may also be used in the process of the invention to modify polyurethane foam properties. These crosslinkers are used in amounts well known to those persons skilled in the art.

25 In addition to the above-mentioned materials, any number of a variety of additives conventionally used in the production of hot-molded polyurethane foams such as, for example, fire retardants, defoamers, anti oxidants, mold release agents, dyes, pigments and fillers can also be used in the process of the present invention. These additives are used in amounts well known to skilled persons.

30 In the process of the present invention, the components can be and typically are introduced to a mixing head where they are thoroughly blended and metered into a mold heated to a temperature between 30°C and 60°C. Then, the mold is closed and a polyurethane foam is allowed to rise in the closed mold. Once the polyurethane foam has risen, the closed mold is heated to a temperature of up to 250°C, preferably between 150°C and 250°C, for
35 several minutes to cure the polyurethane foam which is then demolded. However, preblending of the components, except for the organic isocyanate, can be done if desired. The components are advantageously at room temperature or a slightly elevated temperature when

	CP-3141	is a polyether polyol having a molecular weight of 3,000 sold by The Dow Chemical Company under the trademark VORANOL CP-3141.
5	CP-3111	is a polyether polyol having a molecular weight of 3,000 sold by The Dow Chemical Company under the trademark VORANOL CP-3111.
	Monol A	is a polyether monoalcohol based on propylene oxide having the ethylene oxide content of 0 percent and a molecular weight of 190.
10	Monol B	is a monohydroxy polyalkylene adduct having a propylene oxide content of 93 percent, an ethylene oxide content of 7 percent and a molecular weight of 1400.
15	Monol C	is a monohydroxy polyalkylene adduct having a propylene oxide content of 50 percent, an ethylene oxide content of 50 percent and a molecular weight of 500.
	PEG 4000	is a polyethylene glycol having a molecular weight of 4,000.
20	PEG 1450	is a polyethylene glycol having a molecular weight of 1,450.
	PEG 12000	is a polyethylene glycol having a molecular weight of 12,000.
25	TPEG-3000	is an all ethylene oxide triol having a molecular weight of 3,000.
	PMDETA	is pentamethyldiethylene triamine sold by Air Products and Chemicals Inc. under the trademark POLYCAT 5.
30	NEM	is N-ethylmorpholine sold, for example, by Air Products and Chemicals Inc., and Texaco.
	Dabco 33LV	a 33 percent solution of triethylene diamine in dipropylene glycol, sold by Air Products and Chemicals Inc. under the trademark DABCO 33LV.
35	Dabco XDM	is N,N-dimethylethyl-N-morpholine sold by Air Products and Chemicals Inc. under the trademark DABCO XDM.

	Niax A-1	is 70 percent bis(2-dimethylaminoethyl)ether solution in DPG, sold by OSI Specialties S.A. under the trademark NIAx A-1.
	SO	is stannous octoate.
5	B-8002	is silicone surfactant sold by Th. Goldschmidt under the trademark Tegostab B-8002.
	BF-4900	is silicone surfactant sold by Th. Goldschmidt under the trademark Tegostab BF-4900.
	L-620	is silicone surfactant sold by OSI Specialties S.A. under the trademark Niax Surfactant L-620
10	TDI-80	is an 80:20 mixture of the 2,4- and 2,6-toluene diisocyanate isomers sold by The Dow Chemical Company under the trademark Voranate T80.
15	Index	is the ratio of the amount of reactive isocyanate groups in the reaction mixture divided by the amount of active hydrogen groups in the reaction mixture multiplied by 100.

Properties of the polyurethane foams given in the examples below are
 20 determined according to the following test methods:

	Air Flow (cfm)	is measured according to the ISO 7231 test method (on AMSCOR foam porosity instrument).
	Density	is measured according to the DIN 53420 test method.
25	Density 1 skin	is measured according to a Renault Method 1045.
	CFD 25% (kPa)	is Compression Force Deflection determined according to DIN 53577.
	CFD 40% (kPa)	is Compression Force Deflection determined according to DIN 53577.
30	CFD 50% (kPa)	is Compression Force Deflection determined according to Renault Method 1003.
	CFD 65% (kPa)	is Compression Force Deflection determined according to DIN 53577.
	IFD 40% (N)	is Indentation Force Deflection determined according to DIN 53576.
35	Comp. Set 50%	is measured according to DIN 53572.
	Comp. Set 75%	is measured according to ASTM 3574.
	Comp. Set 70% 1 skin	is measured according to Renault Method 1046.

	Wet Comp. Set 70% 1 skin	is measured according to Renault Method 1637.
	Tensile Strength (kPa)	is determined in accordance with ASTM 3574.
	Dynamic Fatigue	is determined according to Renault Method RP 1047.
5	Resilience	is determined in accordance with ASTM 3574.
	Tear Strength (N/m)	is determined in accordance with ASTM 3574.
	SAG Factor	calculated as the ratio of the CFD at 65 percent compression divided by the CFD at 25 percent compression using DIN 53577 test method.
10		

The following examples are given to illustrate the invention and should not be interpreted as limiting it in any way. Unless stated otherwise, all parts and percentages are given by weight.

15 Examples 1 and 2 and Comparative Examples C-1 and C-2

The polyurethane foams were produced in the laboratory by pouring foam formulations shown in Table 1 into a heated mold, allowing the foam to rise and then curing it at 160°C for 10 minutes. The foam was then demolded. Foam properties are shown in Table 1:

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Table 1

	<u>Example</u>		<u>C-1</u>	<u>C-2</u>	<u>1</u>	<u>2</u>
	<u>Formulation:</u>					
5	CP-3141	parts	96	96	88	88
	Monol B	parts	0	0	8	8
	PEG-4000	parts	4	4	4	4
	Dabco 33LV	parts	0.2	0.2	0.2	0.2
10	PMDETA	parts	0	0	0.08	0.08
	Niax A1	parts	0.07	0.07	0	0
	NEM	parts	0.15	0.15	0.15	0.15
	BF-4900	parts	1.0	1.0	1.2	1.2
15	SO	parts	0.2	0.2	0.18	0.18
	Water	parts	4	4	4	4
	T-80	Index	97	97	97	97
	<u>Mold Temperature at Pour</u>	°C	39	50	39	50
	<u>Foam Properties:</u>					
20	Molded Density	kg/m ³	33	30	32	29
	Density 1 skin	kg/m ³	31.1	27.5	30.6	26.4
	IFD 40%	N	148	109	132	113
	Air Flow	SCFM	3.3	3.1	3.5	4.2
25	CFD 25%	kPa	1.92	1.48	1.89	1.48
	CFD 50%	kPa	3.01	2.10	2.80	2.23
	CFD 65%	kPa	4.61	3.12	4.57	3.48
	SAG Factor		2.40	2.11	2.47	2.35
	Comp. Set 70% 1 skin	%	11.8	12.2	13.0	7.91
30	Wet Comp. Set 70% 1 skin	%	13.6	14.5	14.9	15.1
	Dynamic Fatigue:					
	height loss	%	3.15	2.11	2.12	2.03
	CFD loss	%	18.6	15.7	18.0	15.7
	Tear Strength	N/m	552	377	395	375
35	Note:	Comparative Examples C-1 and C-2 are not examples of this invention				

As can be seen from Table 1, foams prepared in Examples 1 and 2 exhibit superior air flow characteristics, lower hardness at a lower mold temperature, and better compression set with skin at a higher mold temperature than foams prepared in Comparative Examples C-1 and C-2. Other properties of the foams prepared in Examples 1 and 2 are acceptable.

5 Example 3 and Comparative Examples C-3 to C-4

Polyurethane foams were produced by pouring foam formulations shown in Table 2 below into a mold heated to a temperature of 33°C to 34°C using a WEMA low pressure pouring machine, allowing the foam to rise and then curing it at 160°C for 12 minutes. The foam was then demolded. Foam properties are shown in Table 2. As can be seen from Table 2,
10 foams prepared in Example 3 exhibit superior air flow and softness characteristics than foams prepared in Comparative Examples C-3 and C-4. Other properties of the foams prepared in Example 3 are acceptable.

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Table 2

	<u>Example</u>		<u>C-3</u>	<u>C-4</u>	<u>3</u>
5	<u>Formulation:</u>				
	CP-3141	parts	100	100	93.3
	Monol A	parts	0	0	6.7
	PEG-4000	parts	0	6.7	6.7
10	Dabco 33LV	parts	0.08	0.08	0.08
	NEM	parts	0.12	0.12	0.12
	B-8002	parts	1.1	1.1	1.1
	Niax A1	parts	0.05	0.05	0.05
	SO	parts	0.10	0.16	0.18
15	Water	parts	3.35	3.35	3.35
	T-80	Index	100	100	100
	<u>Foam Properties:</u>				
20	Free Rise Density	kg/m ³	34.5	31.9	36.2
	Surface Cure at Demold		OK	OK	OK
	Air Flow	cfm	3.0	2.9	3.3
	Density	kg/m ³	40.4	36.9	40.0
	CFD 40%	kPa	4.5	3.3	2.1
25	50% Comp. Set	%	3.1	5.2	13.0
	Tensile Strength	kPa	151	108	89
	Tear Strength	N/m	787	608	550
	IFD 40%	N	245	167	121
30	Note:	Comparative Examples C-3 to C-4 are not examples of this invention			

Examples 4 to 8 and Comparative Example C-5

Polyurethane foams were produced by pouring foam formulations shown in Table 3 into a mold heated to a temperature of 33°C to 34°C using a WEMA low pressure pouring machine, allowing the foam to rise and then curing it at 160°C for 12 minutes. The foam was then demolded. Foam properties are shown in Table 3. As can be seen from Table 3, Examples 4 to 8 demonstrate that the use of a combination of Monol B and polyethylene glycols having a molecular weight greater than 1,000 results in polyurethane foams with good physical properties and exceptional low hardness values, previously achievable only through the use of CFC-11 as the auxiliary blowing agent. Comparative Example C-5 demonstrates that the use of Monol B alone results in a polyurethane foam having much higher hardness.

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Table 3

<u>Example</u>		<u>C-5</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	
5	<u>Formulation:</u>							
	CP-3141	parts	86	86	86	86	86	
	Monol B	parts	14	14	14	14	14	
	PEG-1,450	parts	0	8	0	0	0	
10	PEG-4000	parts	0	0	4	6	0	
	PEG-12,000	parts	0	0	0	0	2	
	Dabco 33LV	parts	0.071	0.071	0.071	0.071	0.071	
	Dabco XDM	parts	0.107	0.107	0.107	0.107	0.107	
	PMDETA	parts	0.14	0.14	0.14	0.14	0.14	
15	L-620	parts	0.50	0.50	0.50	0.50	0.50	
	B-8002	parts	0.50	0.50	0.50	0.50	0.50	
	SO	parts	0.15	0.15	0.15	0.15	0.15	
	Water	parts	4.0	4.0	4.0	4.0	4.0	
20	T-80	Index	100	100	100	100	100	
	<u>Foam Properties:</u>							
	Core Density	kg/m ³	24.8	26.2	25.2	26.6	26.4	24.7
	Air Flow	cfm	4.4	5.0	5.5	5.3	4.4	4.0
25	CFD 40%	kPa	2.1	1.6	1.7	1.8	1.5	1.8
	Comp. Set 50%	%	4.7	5.1	4.5	4.3	5.05	4.0
	Resilience	%	42	43.5	43.5	47.5	46	42

Note: Comparative Example C-5 is not an example of this invention

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Examples 9 and 10 and Comparative Example C-6

Polyurethane foams were produced by pouring foam formulations shown in Table 4 below into a mold heated to a temperature of 33°C to 34°C using a WEMA low pressure pouring machine, allowing the foam to rise and then curing it at 160°C for 12 minutes. The foam was then demolded. Foam properties are shown in Table 4. As can be seen from Table 4, foams prepared in Examples 9 and 10 using a combination of Monol C and TPEG-3000 exhibit superior air flow and softness characteristics than foams prepared in Comparative Examples C-6 using only TPEG-3000. Other properties of the foams prepared in Example 3 are good.

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Table 4

	<u>Example</u>		<u>C-6</u>	<u>9</u>	<u>10</u>
5	<u>Formulation:</u>				
	CP-3111	parts	100	100	93.3
	Monol C	parts	0	8	8
	TPEG-3000	parts	3	4.2	8
10	Dabco 33LV	parts	0.15	0.15	0.15
	Dabco XDM	parts	0.15	0.15	0.15
	B-4900	parts	1.2	1.2	1.2
	Niax A1	parts	0.05	0.05	0.05
	SO	parts	0.13	0.13	0.13
15	Water	parts	4.5	4.5	4.5
	T-80	Index	100	100	100
	<u>Foam Properties:</u>				
	Core Density	kg/m ³	30.8	31.7	32.3
20	Air Flow	cfm	4.0	4.7	4.3
	CFD 40%	kPa	4.33	3.28	2.60
	Comp. Set 75%	%	6.8	9.5	10.4

Note: Comparative Example C-6 is not an example of this invention

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CLAIMS

1. A process for producing a soft, flexible, hot molded polyurethane foam which process comprises reacting a polyol formulation comprising a polyether polyol, a non-trimerization polyurethane catalyst and water with an organic isocyanate under hot molding conditions, characterized in that said polyol formulation further comprises (a) at least one
5 poly(oxyalkylene) polyether polyol having functionality of at least two, an ethylene oxide content of at least 80 percent and a molecular weight greater than 1,000; and (b) at least one monofunctional additive.
2. A process according to Claim 1 wherein the reaction of the polyol formulation, the polyurethane catalyst and water with the organic isocyanate is carried out in a
10 closed mold heated to a temperature between 30°C and 60°C, the resulting polyurethane foam is cured in the closed mold heated to a temperature of up to 250°C and the polyurethane foam is then demolded.
3. A process according to Claim 1, wherein said poly(oxyalkylene) polyether polyol is a poly(oxyethylene) polyether polyol having a molecular weight greater than 1,000.
- 15 4. A process according to Claim 1, wherein said poly(oxyethylene) polyether polyol has a molecular weight between 2,000 and 12,000.
5. A process according to Claim 3 or Claim 4, wherein said poly(oxyethylene) polyether polyol is a polyethylene glycol.
6. A process according to Claim 3 or Claim 4, wherein said poly(oxyethylene)
20 polyether polyol is a poly(oxyethylene) triol.
7. A process according to Claim 1, wherein said poly(oxyalkylene) polyether polyol is a poly(oxyethylene/oxypropylene) polyether polyols having an ethylene oxide content of at least 80 percent and a molecular weight greater than 1,000.
8. A process according to Claim 1, wherein said poly(oxyalkylene) polyether
25 polyol is a poly(oxyethylene/oxypropylene) polyether polyols having an ethylene oxide content of at least 80 percent and a molecular weight between 2,000 and 12,000.
9. A process according to Claim 1, wherein said poly(oxyalkylene) polyether polyol and said monofunctional additive are each used in an amount of from 0.1 to 20 php of the polyol formulation.
- 30 10. A process according to Claim 1, wherein said monofunctional additive is a monol, amine or monocarboxylic acid.
11. A polyurethane foam whenever prepared according to any one of Claims 1 to 10.

INTERNATIONAL SEARCH REPORT

Inter. Appl. Application No

PCT/EP 95/00714

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C08G18/28 C08G18/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C08G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP,A,0 361 334 (DOW) 4 April 1990 cited in the application see page 2, line 51 - page 4, line 43; claims 1-11; examples	1-4
Y	EP,A,0 386 974 (PMC) 12 September 1990 see page 3, line 27 - page 4, line 45; claims 1-15	1,10
Y	US,A,4 347 330 (DEMOU ET AL) 31 August 1982 see column 3, line 9 - column 8, line 43 see column 12, line 9 - line 34; claims 1,2	1,10
A	FR,A,2 162 490 (DUNLOP) 20 July 1973 see page 1, line 28 - page 2, line 17; claims 1-3	1

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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